



01/194  
Doc/24273

27 July 1992

Department of Aboriginal Sites  
W.A. Museum  
35 Havelock Street  
WEST PERTH WA 6005

**Attention: Registrar of Aboriginal Sites**

Dear Sir,

We are pleased to submit our report "Ground Probing Radar Survey - Phase 3, Rottneest Island, Western Australia, July 1992".

The Phase 3 survey has provided a clearer view of the extent of the road intersection cemetery site. Though isolated zones of disturbed ground have been found close to the survey boundaries it is clear that the main areas of disturbance are contained within these boundaries.

The four reconnaissance profiles in Tentland have identified areas requiring additional profiling to more thoroughly evaluate their origin and possibly confirm them as disturbed ground.

It is considered highly unlikely that a second cemetery exists north of line K-003 in Tentland due to a relatively shallow water table and limestone within two metres from the surface in this region.

We are most grateful for the assistance provided by personnel from your Department, which we believe has helped to make this survey a success.

Yours sincerely,

V.C. Wilson  
Senior Lecturer, Exploration Geophysics

s:rottneest.rep/dsk2



**GROUND PROBING RADAR SURVEY - PHASE 3  
ROTTNEST ISLAND, WESTERN AUSTRALIA  
JULY 1992**

**FOR**

**DEPARTMENT OF ABORIGINAL SITES  
W.A. MUSEUM**

**Volume 1**

**Department of Exploration Geophysics  
Curtin University of Technology**

**July 1992**



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## 1. INTRODUCTION

Ground Probing Radar Survey - Phase 3, Rottnest Island, WA, is the third ground probing survey conducted by the Department of Exploration Geophysics (DEG), Curtin University, on behalf of the Department of Aboriginal Sites, WA Museum, to delineate 19th century burial sites on Rottnest Island.

Further to a preliminary investigation in 1990 of the known cemetery on Rottnest Island using several geophysical methods, the DEG recommended the use of ground probing radar in a trial survey over the road intersection area to the south of Tentland.

A three day trial ground probing radar survey was conducted during the period 10 to 12 December, 1990 and a report was submitted on the work, entitled "Trial Ground Probing Radar Survey, Tentland Area, Rottnest Island, Western Australia", February 1991, by the Department of Exploration Geophysics, Curtin University of Technology. The report concluded that the ground probing radar method had successfully identified disturbed ground in the form of trenches, which had most likely been dug as burial sites, in the vicinity of the road intersection immediately south of the Tentland area. The report recommended further ground probing radar profiling to the east, south and west of the intersection grid to more fully determine the extent of the trenches. Also, it recommended further work on an area in northern Tentland, and to the west of the profile grid, over which single ground probing radar profiles had indicated the possibility of ground disturbance.

A five day survey was conducted during the period 11 to 15 March, 1991. This work was mainly based on the recommendations of the earlier report. It included some additional work on one area identified to the Department of Aboriginal Sites by Mr. J. O'Donoghue as possibly containing a burial site.

2. A report was submitted on this work entitled, "~~Ground Probing Radar Survey, Rottnest Island, WA, March 1991~~" by the Department of Exploration Geophysics, Curtin University of Technology. The report concluded that further disturbed ground had been found in the form of trenches within the vicinity of the road intersection immediately south of the Tentland area. However, no evidence of possible burials was found in the area investigated in northern Tentland.

This Phase 3 survey was carried out to determine more fully the extent of the road intersection burial area, as well as to investigate an additional area of Tentland. The survey period was from 11 May 1992 to 15 May 1992 inclusive.

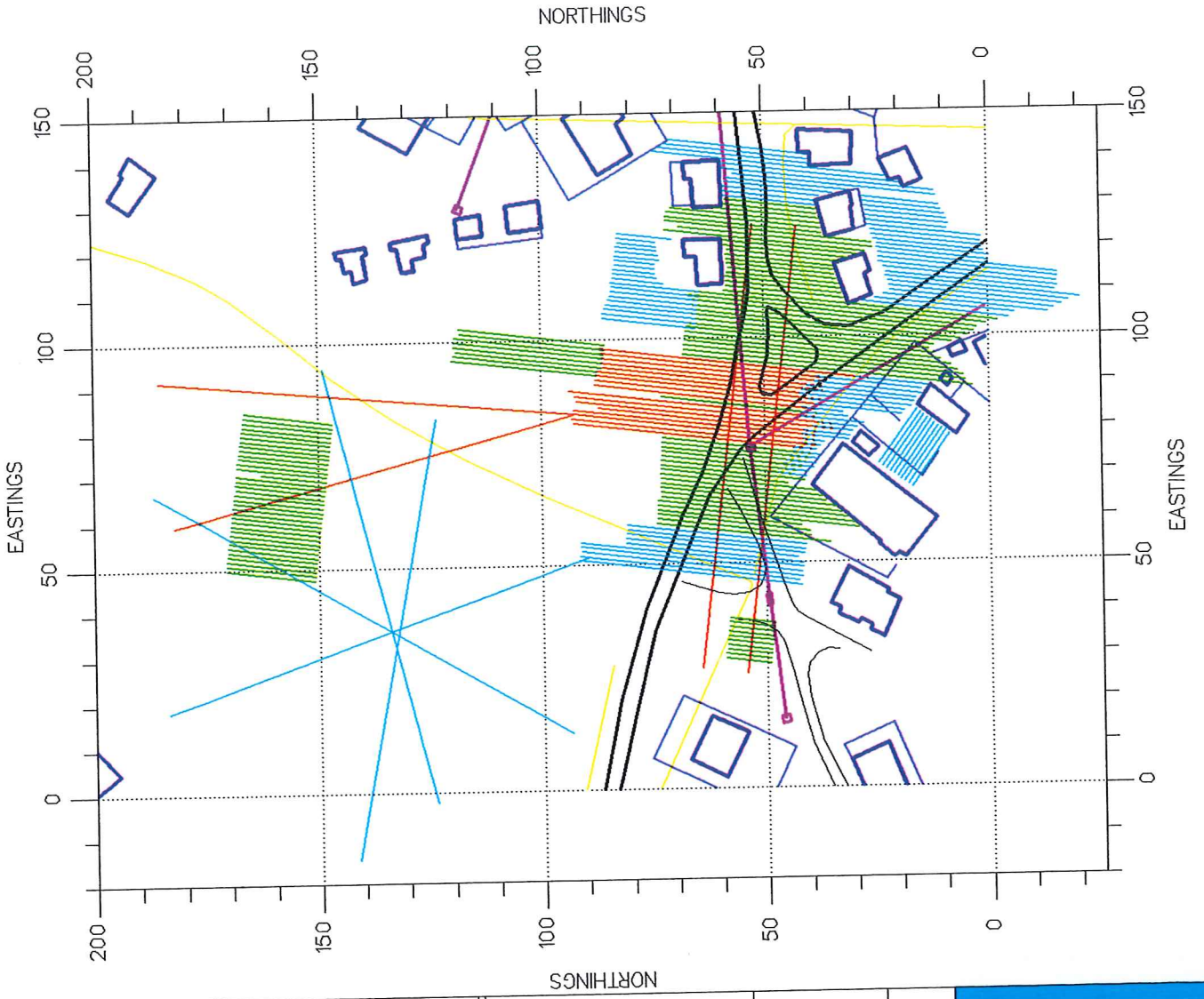
This report is based upon the results of all work completed, and presents site data from the Phase 3 survey.

## 2. JOB PHILOSOPHY

The two previous ground probing radar surveys had clearly identified trench-like zones of apparently disturbed ground, extending to a depth of 1.5 to 2.5 metres in the road intersection area, south of Tentland. It had been concluded that these zones could be burial sites, known to occur in this area.







TITLE : Phase 3 - GPR Survey Map  
 CLIENT : Curtin University/ WA Museum  
 COUNTRY : Western Australia  
 AREA : Rottneest Island

	EASTINGS	NORTHINGS
MAXIMUM	150.00	200.00
MINIMUM	-20.00	-25.00

SCALE: 1 : 1500.00      DATE: July 1992

Produced by: Ground Radar Australia Pty Ltd, Perth, Australia

**GROUND**  
**GRADAR**  
**AUSTRALIA**



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The Phase 3 survey was planned to determine the lateral extent of the area containing possible burial sites. Additionally four reconnaissance ground probing survey lines were completed over a location in Tentland recommended to the Department of Aboriginal Sites by Mr P Allerdycce.

The Department of Exploration Geophysics contracted Ground Radar Australia Pty Ltd to provide ground probing radar equipment and operator (Mr C Frampton) to acquire and process the data. Mr V Wilson of DEG supervised the work, interpreted the data and prepared this report.

### 3. GROUND PENETRATING RADAR (GPR) METHOD

The GPR technique is designed to show a cross-section of the earth layers. An electromagnetic pulse is sent into the ground where it is reflected by boundaries within the earth and returned to the surface. The received pulse is digitised and stored for later display. Disturbed strata is evidenced by discontinuities in the reflected data.

The pulse is of the order of 10 nanoseconds long and has a bandwidth of between 10 to 200 MegaHertz. The reflecting boundaries in the earth are changes in conductivity. As the velocity of the electromagnetic wave is very fast (of the order of 0.1 metres/nanosecond) the recording time is very short. Typical values of 700 nanoseconds to record 30 metres depth. With this short recording time and the stationarity of the pulse wavelet, it is possible to record many times at one point and sum the recordings together. This improves the signal to random noise ratio and values of 100 to 300 stacks of waveform are usual.

The GPR technique is very similar to the seismic exploration used in the oil industry. Previous GPR systems recorded the data onto small thermal paper plotters in the field. All information was recorded by analog. The state-of-the-art equipment over the last year now uses digitisation of the recorded signals to store the data in 16 bit samples. This increases the dynamic range of the system greatly. The major differences from the seismic to the GPR techniques are that the seismic wave is reflected by impedance (velocity/density) contrasts in the earth, whereas the GPR wave is reflected by conductivity contrasts.

Penetration of the GPR signal is limited by the water content and salinity and clay content of the earth layers. In ideal conditions, penetration can be more than 10 metres. Further research into low frequency GPR antennas and more powerful transmitters is being carried out.

### 4. DATA ACQUISITION

Data was acquired during the period 11 May to 15 May 1992, by Mr C Frampton of Ground Radar Australia Pty Ltd. The survey was supervised by Mr V Wilson of the Department of Exploration Geophysics.

Assistance was provided by:

*Messrs B Blurton, J Patterson  
Messrs G Merritt, P Gow, H Bropho  
Mr P Boss*

*Dept of Aboriginal Sites  
Rottnest Island Deaths Group  
DEG, Curtin Uni. of Tech.*

We are grateful to the staff of the Rottnest Island Board for their every assistance.



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The GPR system used was the Pulse EKKO IV. The system comprises a 200 MHz transmitter and receiver. The receiver antenna digitises the signal at the antenna before passing the data to the console via fibre optic cables.

Data was recorded from three regions:

1. Extensions to the lines of the main grid at the road intersection area.
2. Within the backyard of the Single Persons Cottage near Manhole 32 and up to the Gardener's Cottage.
3. Four lines in Tentland.
  - *See Table 1 for Survey Line Listings and Appendix B for Line Descriptions.*
  - *See Appendix C for photographs taken of the site during data acquisition.*



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## SURVEY LINE LIST

### AREA 1

Extending Main Grid towards South and Old Hospital.

Baseline used was 32.1m South of Main Grid Line (26.0m N).

LINE	INTERSECTI ON -NEW BASELINE	FIELD RANGE (M)	NEW RANGE (M)	TRACES
A035E	22.8	0.6 - 33.2	-28.2 - 4.4	164
A036E	24.1	0.6 - 31.6	-29.4 - 1.6	156
A037E	31.15	0.4 - 37.0	-36.8 - -0.2	184
A038E	32.85	0.8 - 37.2	-38.0 - -1.6	183
A039E	34.2	0.6 - 39.0	-39.6 - -1.2	193
A040E	35.7	0.6 - 40.8	-41.0 - -0.8	202
A041E	38.1	0.6 - 43.8	-43.4 - -0.2	217
A042E	31.8	0.0 - 37.6	-37.8 - -0.2	189
A043E	32.65	0.4 - 39.2	-38.2 - 0.6	195
A044E	32.4	0.4 - 40.2	-38.0 - 1.8	200
A045E	32.9	0.8 - 40.6	-38.0 - 1.8	200
A046E	32.4	0.4 - 40.4	-38.0 - 2.0	201
A047E	16.25	0.0 - 24.8	-22.2 - 2.6	125
A048E	16.7	0.2 - 25.0	-22.4 - 2.4	125
A049E	15.45	0.6 - 24.8	-20.8 - 3.4	122
A050E	15.1	0.2 - 25.0	-20.8 - 4.0	125
A051E	14.45	0.4 - 24.8	-20.0 - 4.4	123
A052E	14.4	0.2 - 25.4	-20.2 - 5.0	127
A053E	6.9	0.4 - 19.6	-12.4 - 6.8	97

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A054E	6.9	0.2 - 18.8	-12.6 - 6.0	94
A055E	6.9	0.8 - 18.6	-12.0 - 5.8	90
A056E	5.8	0.4 - 18.2	-11.4 - 6.4	90
A057E	5.4	0.8 - 18.2	-10.6 - 6.8	88
A058E	4.15	0.2 - 17.4	-10.0 - 7.2	87

NO	DEPTH (M)	VELOCITY (M/S)	APPARENT VELOCITY (M/S)	TIME (NS)
1	0.0 - 0.2	1500	1500	133
2	0.2 - 0.4	1500	1500	267
3	0.4 - 0.6	1500	1500	400
4	0.6 - 0.8	1500	1500	533
5	0.8 - 1.0	1500	1500	667
6	1.0 - 1.2	1500	1500	800
7	1.2 - 1.4	1500	1500	933
8	1.4 - 1.6	1500	1500	1067
9	1.6 - 1.8	1500	1500	1200
10	1.8 - 2.0	1500	1500	1333
11	2.0 - 2.2	1500	1500	1467
12	2.2 - 2.4	1500	1500	1600
13	2.4 - 2.6	1500	1500	1733
14	2.6 - 2.8	1500	1500	1867
15	2.8 - 3.0	1500	1500	2000
16	3.0 - 3.2	1500	1500	2133
17	3.2 - 3.4	1500	1500	2267
18	3.4 - 3.6	1500	1500	2400
19	3.6 - 3.8	1500	1500	2533
20	3.8 - 4.0	1500	1500	2667
21	4.0 - 4.2	1500	1500	2800
22	4.2 - 4.4	1500	1500	2933
23	4.4 - 4.6	1500	1500	3067
24	4.6 - 4.8	1500	1500	3200
25	4.8 - 5.0	1500	1500	3333
26	5.0 - 5.2	1500	1500	3467
27	5.2 - 5.4	1500	1500	3600
28	5.4 - 5.6	1500	1500	3733
29	5.6 - 5.8	1500	1500	3867
30	5.8 - 6.0	1500	1500	4000



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**AREA 2**

Single Persons Quarters near Manhole 32 - Back Yard.

Line displayed as recorded. Shooting direction starting at edge of concrete path nearest Single Persons Quarters and shooting towards old Gardeners Cottage.

Lines shot in direction : 128 degrees magnetic.

Line 1 - is 10.38m from East Front Fence.

Line 1 - is 8.65m from East Front of Single Persons Quarters.

Area contains two Hills Hoists and one Brick Barbecue.

LINE	FIELD RANGE (M)	NEW RANGE (M)	TRACES
J001	0.2 - 14.8	0.2 - 14.8	74
J002	0.2 - 14.8	0.2 - 14.8	74
J003	0.2 - 14.6	0.2 - 14.6	73
J004	0.2 - 14.6	0.2 - 14.6	73
J005	0.2 - 14.6	0.2 - 14.6	73
J006	0.2 - 14.4	0.2 - 14.4	72
J007	0.2 - 14.4	0.2 - 14.4	72
J008	0.2 - 14.4	0.2 - 14.4	72
J009	0.2 - 14.8	0.2 - 14.8	74
J010	0.2 - 14.4	0.2 - 14.4	72

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## AREA 3

Extending Main Grid South. All lines have 0.0m on Main Grid Baseline (26.0m). Tape readings increase to South.

LINE	FIELD RANGE (M)	NEW RANGE (M)	TRACES
A000E	10.0 - 16.0	10.0 - 16.0	31
A001E	12.0 - 22.0	4.0 - 14.0	51
A002E	11.0 - 20.0	6.0 - 15.0	46
A003E	10.0 - 15.0	11.0 - 16.0	26
A004E	12.0 - 15.8	10.2 - 14.0	20
A005E	12.0 - 16.6	9.4 - 14.0	24
A006E	11.6 - 22.0	4.0 - 14.4	53
A007E	13.8 - 22.6	3.4 - 12.2	45
A008E	15.0 - 23.4	2.6 - 11.0	43
A009E	10.8 - 24.8	1.2 - 15.2	71
A010E	11.0 - 21.2	4.8 - 15.0	52
A011E	13.6 - 33.0	-7.0 - 12.4	98
A012E	12.0 - 33.6	-7.6 - 14.0	105
A013E	10.0 - 34.8	-8.8 - 16.0	125
A014E	10.2 - 35.4	-9.4 - 15.8	127
A015E	11.4 - 35.8	-9.8 - 14.6	123
A016E	13.0 - 36.8	-10.8 - 13.0	120
A017E	13.2 - 36.8	-10.8 - 12.8	119
A018E	22.0 - 38.0	-12.0 - 4.0	81
A001W	9.0 - 15.8	10.2 - 17.0	35
A002W	8.8 - 15.2	10.8 - 17.2	33
A003W	8.0 - 14.8	11.2 - 18.0	35
A004W	8.0 - 13.8	12.2 - 18.0	30

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A005W	7.0 - 13.4	12.6 - 19.0	33
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**AREA 4**

Extension to Main Grid Westwards. Tape Reading 15.0m for each line is on Main Grid Baseline (26.0m). Tape readings increase Northwards.

LINE	FIELD RANGE (M)	NEW RANGE (M)	TRACES
A020W	0.0 - 40.2	11.0 - 51.2	202
A021W	0.0 - 40.0	11.0 - 51.0	201
A022W	0.2 - 40.0	11.2 - 51.0	200
A023W	1.4 - 40.0	12.4 - 51.0	194
A024W	0.0 - 40.0	11.0 - 51.0	201
A025W	0.0 - 50.0	11.0 - 61.0	251
A026W	0.2 - 50.0	11.2 - 61.0	250
A027W	0.0 - 49.6	11.0 - 60.6	249
A028W	0.6 - 50.0	11.6 - 61.0	254
A029W	0.0 - 50.0	11.0 - 61.0	251

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### AREA 5

Four Lines recorded in Northern Tentland. On Line 1 0.0m is 48.0mN on Line A028W (Baseline - 15.0m).

On Line 1 - 0.0m is 43.2m from Manhole 32 at bearing 149.5 degs. mag.

Centre Peg for these Lines is 47.1m from 0.0m on Line 1 at bearing 343.5 degs. mag.

Line K003 is offset from intersecting Centre Peg by 1.7m East.

Table shows Bearing of Line and intersection with Centre Peg.

LINE	RANGE (M)	TRACE S	BEARING	CENTRE PEG
K001	0.0 - 99.8	500	343.5	47.1
K002	1.0 - 108.4	538	33.0	47.5
K003	0.8 - 100.0	497	103.5	52.0
K004	0.2 - 99.8	499	78.5	39.6

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### AREA 6

Extending Main Grid Eastwards. Tape Readings increase to South.  
Intersections in Table show line crossing Main Grid Baseline (26.0m).

LINE	INTERSECTION	FIELD RANGE (M)	NEW RANGE (M)	TRACES
A055E	12.2	0.2 - 21.2	17.0 - 38.0	106
A056E	12.8	0.4 - 21.4	17.4 - 38.4	106
A057E	13.05	0.6 - 22.4	16.6 - 38.4	110
A058E	12.05	0.0 - 24.4	13.6 - 38.0	123
A059E	12.75	0.8 - 28.0	10.8 - 38.0	137
A060E	12.85	2.4 - 47.8	-9.0 - 36.4	228
A061E	13.05	0.2 - 47.6	-8.6 - 38.8	238
A062E	13.85	1.0 - 40.6	-0.8 - 38.8	199
A063E	29.4	0.8 - 52.8	2.6 - 54.6	261
A064E	27.85	0.4 - 34.4	19.4 - 53.4	171
A065E	27.6	0.8 - 33.4	20.2 - 52.8	164
A066E	27.6	0.4 - 31.6	20.2 - 51.4	157

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### AREA 7

Extending Main Grid Northwards.

Line A033E was read with tape 0.0mN on Main Grid Baseline (26.0m).

Lines A034E to A044E were read with New Baseline 34.5mN of Main Grid Baseline (26.0m).

Line A032E was read with the tape 0.0mN on Main Grid Baseline (26.0m).

Lines A025E to A031E were read with New Baseline shown at 0.0mN on tape.

LINE	BASELINE	FIELD RANGE (M)	NEW RANGE (M)	TRACES
A025E	35.3	15.0 - 35.8	41.0 - 61.8	105
A026E	35.3	15.0 - 36.0	41.0 - 62.0	106
A027E	35.3	15.0 - 35.6	41.0 - 61.6	104
A028E	35.3	15.0 - 35.4	41.0 - 61.4	103
A029E	35.3	15.0 - 35.2	41.0 - 61.2	102
A030E	34.95	15.0 - 34.8	41.0 - 60.8	100
A031E	34.9	15.0 - 34.8	41.0 - 60.8	100
A032E	*SEE ABOVE	15.0 - 34.6	41.0 - 60.6	99
A033E	*SEE ABOVE	15.0 - 35.0	41.0 - 61.0	101
A034E	12.0	0.6 - 12.0	49.2 - 60.6	58
A035E	10.6	0.8 - 10.6	50.8 - 60.6	50
A036E	9.7	0.2 - 9.6	51.2 - 60.6	48
A037E	9.95	0.8 - 9.8	51.4 - 60.4	46
A038E	9.2	0.2 - 9.2	51.6 - 60.6	46
A039E	10.2	0.2 - 10.2	50.6 - 60.6	51
A040E	10.4	0.8 - 10.4	51.0 - 60.6	49
A041E	9.6	0.4 - 9.6	51.4 - 60.6	47
A042E	9.7	0.8 - 9.6	51.6 - 60.4	45
A043E	8.95	0.4 - 9.0	52.0 - 60.6	44
A044E	12.45	0.2 - 12.4	48.4 - 60.6	62

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## 5. PROCESSING

The velocity used for time-depth conversion was chosen from a Walkaway Test in a previous survey. This showed velocities from 0.13 m/ns to 0.12m/ns. A velocity of 0.13 m/ns was chosen for the GPR data as being representative of the shallow region 0m to 4m.

### Processes Used

#### **Time Zero Drift Correction**

A time static correction applied trace by trace to remove small timing jitters

#### **Signal Saturation Correction**

Removes the low frequency interference caused by antenna-ground coupling

#### **Amplitude Gain Recovery**

A time varying gain correction is applied to compensate for amplitude losses due to spherical spreading and ohmic dissipation of the signal.

#### **Wavelet Shaping**

Process to improve balance of amplitude spectrum

#### **F-K Filter**

A frequency-wavenumber or 2-Dimensional Filter. Used to remove data with specified dip limits from the GPR section.

#### **Mix**

Trace summation in a rollalong fashion. Weights are given in percentages. Used to increase coherent signal and attenuate random noise.

#### **Bandpass Filter**

This filter excludes frequencies above and below certain limits with a taper to each limit. The filter is applied to remove frequencies which are outside the signal range or that contain too high noise.

#### **Scaling**

Time variant scaling of the AGC (Automatic Gain Control) variety to balance the trace temporally. The AGC uses a window of sample and computes a new factor. A percentage of the ungained data can be mixed to the gained data.

### **Displays**

Variable Area - The amplitudes of each trace are shown as a wiggle trace with the positive amplitudes being shaded black.

Colour Amplitude - The amplitudes of each trace are displayed in colour. The positive amplitudes tend towards red, while the negative amplitudes tend towards blue.

## 6. RESULTS

The processed ground probing radar data are presented as profiles at Appendix D.





## 7. INTERPRETATION

### 7.1 General

As for previous surveys, the GPR data has been interpreted for evidence of zones, defined by discontinuous reflections, which could be caused by digging. Those recorded and thought of as potential burial sites are 1.5 to 2.5 metres deep and appear on more than one profile line.

A map showing the location of these zones is presented at Appendix A, as an Interpretation Plan.

Reflections of the radar signal from housing, water pipes, sewerage pipes and cables have produced major noise to the measured data. The noise affected data prevents a clear interpretation to be made within one metre of the source. After processing, reflections from trees produced only a minor effect on the data.

### 7.2 The Road Intersection - Main Grid Area

The survey has indicated additional possible burials at the following sites:

- adjacent to the road south-west of the old hospital, remote from other sites.
- within the front garden/lawn area of the gardener's cottage and adjacent to those sites found from previous surveys.
- adjacent to the north-east fence between the gardener's cottage and the single persons cottage.
- adjacent to the golf course road and remote of the major trends further east on this road.
- to the west and north of hut B11, remote from the major trends closer to the road.
- between hut B12 and the cabins to the south, mainly adjacent to the road.

It is significant that no evidence for burials was found in the area bounded by the huts south of B11 and B12, the hotel road and the old hospital. Other than two isolated sites adjacent to the hotel road, no further evidence of burials was found south of this area. It would appear that the main cemetery area has been reasonably defined here.

Additional possible sites are found adjacent to the Gardener's Cottage, however, the limestone outcrop at the rear of this cottage excludes an extension to the south west.

The lines completed to the west appear to have determined the western limit of the main cemetery site. However, the possibility of small, remote sites remains, as found on the western most line adjacent of the road.



The northern extent of the cemetery appears to be well defined. The northern most sites appear to be north and northwest of hut B11, and are small and isolated.

The eastern limit to the cemetery would appear to near to the eastern extent of the survey work, but is still not completely defined. Sites appear to be sporadic to the east, family indicating the main cemetery boundary is close to line 66E.

### 7.3 Single Persons Quarters - Back Lawn

The lines completed in this area, J-001 to J-010, did not indicate any possible sites.

### 7.4 Tentland Area

The lines completed in this area were K-001, K-002, K-003 and K-004.

These lines were single profiles. Any evidence found on them needs to be investigated with additional parallel profiles before conclusions could be made fully to establish them as possible burial sites.

Several segments on the lines were found to be worthy of further investigation. However, at this stage none can be considered more than a possibility as they all could be due to natural sedimentary structures and not hand dug.

Those segments requiring further investigation are as follows:

#### Line

K001 5.0-8.6m, 10.4-12.6m, 22.0-25.0m, 28.5-30.6m

K002 Nil

K003 1.2-3.8m, 64.0-66.0m, 73.5-76.0m

K004 10.0-19.0m, 24.0-26.5m, 29-31m

## 8. CONCLUSIONS

The GPR surveys so far completed on Rottnest Island have enabled the delineation of continuous zones of apparently disturbed strata, which are considered likely to constitute burial sites.

The Phase 3 survey has indicated a reduction in areal density of these sites away from the intersection and this is considered likely to indicate the main cemetery has been effectively delineated. Some additional work would be required both east and west on the Golf Course Road to more effectively close off the east, west boundaries.

Segments of profiles completed in Tentland are worthy of further evaluation to more completely determine their potential for burial sites. At this stage it appears possible that they could be due to dug ground.

It is evident from the Tentland data that burials north of line K003 are most unlikely due to shallow limestone and shallow water table.



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## 9. RECOMMENDATIONS

It is recommended that:

1. Additional profile lines be completed to better delineate the eastern and western limits of the road intersection cemetery.
2. Additional profile lines be completed parallel to the segments outlined as having target potential in Tentland. Three lines either side of the initial profile should be adequate, each being twice the length of the segment of interest.
3. It is recommended that any further investigations for a second cemetery site in Tentland should preferably be sited south of line K-003. Both shallow limestone and water table would restrict the development of a cemetery site north of this line.



APPENDIX A  
INTERPRETATION PLAN

